FACTORS ASSOCIATED WITH THE DECLINE OF MORTALITY IN JAPAN, 1950-1970

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Paper presented at the annual meeting of the Population Association of America, New York, April, 1974

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This paper describes some of the findings of a study of patterns of mortality in Japan between 1950 and 1970. During this period the expectation of life at birth in Japan rose almost 12 years for males and almost 14 years for females. This rise was accompanied by varying amounts of change in the 46 prefectures, by changes in the sex mortality differential, and by changes in the cause of death structure.

The history of Japanese mortality for the three decades preceding 1950 has been well described by Taeuber (1958). During that period there was an almost continuous decline in the death rate, except for the war years, and life expectancy rose about 40 percent for both sexes. At the beginning of the period, urban mortality was higher than rural mortality, but this relationship had reversed by 1950. Similarly, in 1920 females had higher death rates than males at almost all ages below 40, but by 1950 male rates were greater at practically all ages and the sex differential in e_0 was well over three years.

During the period mortality convergence was occurring among the prefectures. Those prefectures where mortality had been highest in 1920 experienced the fastest falls in the death rate, so that by 1950 there was much more homogeneity with respect to prefectural mortality.

The so-called preventable diseases are cited by Taeuber as the major causes of mortality in 1920 and also as the major sources of the decline during the next 30 years. Death rates from tuberculosis, influenza, pneumonia, bronchitis, diarrhea, enteritis and other intestinal diseases fell, if irregularly. Death rates from cancer and cardio-vascular diseases, on the other hand, showed little change over the period, and emerged as the major causes of death in 1950.

Many changes in the society were responsible for the patterns of mortality in Japan during these 30 years. Before the war, there were generally rising levels of education, and sanitation and medical care improved. Soon after the war, major applications of new medical and public health knowledge and technology were of primary importance. To my knowledge, no one has attempted to assign measures of relative importance to these various social factors.

The present study attempts to describe the 1950-1970 situation somewhat more precisely. The basic approach is to examine overall mortality in Japan by prefecture for the 20-year period, then deal with causes of death, and finally examine some social, economic, and medical and public health determinants. These findings are compared with pre-1950 trends in Japan and with findings for other countries, mostly the United States.

Mortality trends by sex and cause

Data on life expectancy clearly show a continuation from 1950 to 1970 of mortality trends of the previous 30 years (Table 1). There was a slight increase of the rate of change in e_0 (males, .57 years per year during the first period, .59 years per year during the

second; females, .64 to .69), but the speed of change for the two periods was remarkably similar. There is no clear indication of whether the rate of change has been rising or falling, although the 1965-1970 rise in life expectancy was the lowest since the war. By 1970, the expectation of life at birth in Japan had reached 69.4 years for males and 74.8 for females.

The faster rates of change for females in both periods mean that the sex differential in e_0 must have been growing. From 1.1 years in 1920, the differential rose to about 3.2 years in 1950 and almost 5.4 years by 1970. There are indications, however, that the rate of increase in the differential is slowing. For each successive five-year period from 1950 to 1970, the rate of change fell, and the differential rose by only .2 years between 1965 and 1970.

The convergence among prefectures continued through 1970, as can be documented in several ways. In 1950 the prefectural range for male life expectancy was over seven years; by 1970 it stood at 3.7 years. Corresponding figures for females are 8.4 and 2.2. The ranges of age-standardized death rates fell similarly. Moreover, regression equations relating the 1950-1970 changes in mortality to the initial 1950 levels show that mortality dropped fastest for those prefectures with the highest 1950 rates.

All of the above findings show a continuation of the 1920-1950 trends, and most can be interpreted as indications that Japan is coming closer and closer to minimum currently achievable levels of mortality. This would explain the 1965-1970 slowdown in the rise of e_0, the convergence among the prefectures and also, at least to some extent, the slowing of the change in the sex mortality differential.

Patterns of mortality by cause of death are measured by age-standardized death rates by cause, which conveniently sum to the total age-standardized death rate. Data on cause of death by prefecture are available in a Japanese publication (Segi et al., 1970) already age-standardized, but cover only the years 1955 to 1965. I have not attempted to obtain the voluminous unpublished data from 1970.

The cause groups used are tuberculosis, neoplasms, cardiovascular diseases, intestinal diseases, certain degenerative diseases (diabetes, ulcers, cirrhosis, nephritis and nephrosis), pneumonia and bronchitis, automobile accidents, other accidents, and a residual group which lumps together all other infectious and parasitic diseases, infant and maternal deaths, and deaths from senility and all other causes (Table 2).

The most important causes of death in 1955 were those of the residual group and cardiovascular diseases (Table 3). Most of the deaths (over 60 percent) in the former were due to cause groups B45 and B46, "senility without mention of psychosis, ill-defined, unknown and all other causes", while diseases of infancy and early childhood (B41-44) accounted for about 16-20 percent and "other infectious and parasitic diseases" (B3-17) for about nine percent of the total residual group. The third most important group in 1955 was neoplasms.

By 1965 cardiovascular diseases were clearly the most important contributors to the death rate, with 35 percent, and residual causes were second, with components about as in 1955 except for a fall in infectious and parasitic diseases. Neoplasms were still in third position. In neither year did any other group account for as much as 10 percent of the total death rate, and tuberculosis never more

than seven percent.

Over the ten-year period, the death rates from neoplasms and automobile accidents rose for both sexes, and the death rate from cardiovascular diseases rose for males. Only these three causes showed rising proportions of the total death rate. The fall in mortality over the ten years was due mainly to the fall in the diseases composing the residual group, with changes in tuberculosis and pneumonia and bronchitis of secondary importance. The residual group accounted for over 50 percent of the total fall, and within this group the most important sources of change seem to have been groups B45 and B46, other infectious and parasitic diseases, and diseases of infancy and early childhood.

Many other countries show a similar pattern. (See, for example, Preston, Keyfitz and Schoen, 1972.) A study of the structure of mortality change by Preston and Nelson (n.d.) finds that declines in mortality stem mainly from falls in influenza, pneumonia, bronchitis, other infectious and parasitic diseases and tuberculosis, with cancer and cardiovascular diseases slowing the fall.

We thus find, even late in the "mortality transition", as Japan was between 1955 and 1965, that changes in the preventable diseases still account for a great proportion of the fall in mortality. Such a situation cannot continue indefinitely, of course, and if major future changes are to occur, they must be in disease groups currently accounting for the majority of deaths.

Most of the prefectural differences in mortality in 1955 and 1965 were due to differences in cardiovascular and the residual diseases,

which is not surprising in light of their predominance in the overall death rate (Table 4). The cause groups most important in the drop in variation of the total death rate during the ten years, on the other hand, were the residual group and the intestinal diseases. Changes for cardiovascular diseases were of relatively small importance, and changes in neoplasms ranked last in importance for convergence.

The most important contributor to the sex differential in standardized death rates at given dates during the period was cardiovascular diseases. In 1965 they accounted for about 34 percent of the total difference in death rates by sex (Table 5). Neoplasms were of relatively minor importance in 1955 but by 1965 ranked second in importance in terms of contribution to the sex differential. Also of importance were accidents other than automobile accidents and the residual causes. Retherford (1970) found a similar pattern for the United States, England and Wales, and New Zealand.

The increase in the sex mortality differential was caused mainly by increases in the differential death rates from cardiovascular diseases, followed in importance by neoplasms and automobile accidents. Several of the cause groups showed decreasing sex differentials in the death rates: accidents, tuberculosis, degenerative diseases, pneumonia and bronchitis, and the residual group. These results echo those of Enterline (1961), who found changes at ages 45-64 in the United States due mainly to changes in cardiovascular and cancer differentials. Retherford's study (1972) is also in agreement.

Social determinants of mortality

Perhaps the most hallowed division of socio-economic factors

affecting mortality is into economic variables, on the one hand, and medical and public health variables, on the other: for example, Davis and Arriaga (1969) in their study of Latin American mortality. Much the same distinction has been made in the ongoing discussion about the sources of the postwar mortality decline in Ceylon (Fredericksen, Newman, Meegama: citations are for the latest installments). Slightly more detailed is the set of factors advanced by McKeown and Record (1962), who suggest dividing mortality determinants into genetic factors, therapy, and the environment, with the last including sanitary science and the standard of living.

Finally, Rogers (1960) proposes a "holistic" approach, dividing man's environment into intrinsic and extrinsic components, each with a material and a non-material part. Within this framework almost any conceivable factor affecting mortality may be encompassed. A primary advantage of such an approach is that a researcher may take theoretical note of possibly important factors even if he is not able explicitly to consider them in a given study. This is in contrast to the listing approach, where an author lists factors he considers important but does not let the reader know if he thinks anything else might be operative.

The fact that various determinants may act on different levels is often implicit in discussions of the subject, but far too rarely is this fact made clear. In the current study an attempt to deal with this is made through construction of a framework of three basic levels, with further breakdowns within each. The first level, corresponding to Rogers' intrinsic material environment, concerns inherited and physiological factors, such as genetic makeup and age.

The second level concerns acquired factors: personal habits, the immediate environment, and socio-economic characteristics such as income, education, and occupation. The framework acknowledges such interactions such as the influence on income of education and of income in turn on such personal habits as expenditures on food.

Moving from factors which may be different for each individual and which may be summed for groups, we encounter on the third level factors of the general environment, factors which affect many people in common. These range from the weather to medical services to the level of urbanization.

For the current study, information on as many variables for as many levels and sub-levels of this framework as possible was collected. As is often the case, data were just not available for many potential variables, and for others the type of information found was far from what might be considered ideal. For example, although nutrition is certainly an important factor in mortality determination, no direct information on nutrition was available for the individual prefectures, so data on household expenditures on various items of food were used instead.

The method of analysis chosen was multiple regression. Factor analysis was considered and several trials were made, but the results were somewhat equivocal. In addition, the need for a mathematical factoring was not so important because of the logical framework already established. Another study of Japanese mortality, by Yamamoto and Hayashi (1971) for the years 1960 and 1965, did use the factor analytic approach and the results of that study are in strong agreement with

those of the current project.

After examination of many different correlations and regression equations, nine basic variables were chosen for entering into the multiple regression equations with the standardized death rate as the dependent variable. These variables are (1) expenditures on all food, (2) expenditures on clothing, (3) persons per household, (4) household income, (5) education, (6) occupational structure, (7) doctors per capita, (8) level of urbanization, and (9) average temperature (Table 6). These range from factors close to the individual and summed to arrive at prefectural averages to factors which are assumed to be of fairly equal importance to all of the population of a prefecture. Regressions were run using these variables for each census year from 1950 to 1970.

Zero-order correlations with the death rate show that higher values of two variables are consistently associated with higher death rates (Table 7). These two are average number of persons per household and the percent of the labor force engaged in farming and lumbering. All of the other variables are negatively related with the death rate. These correlations are maintained at each of the five census dates, lending support to the direction of the relationships even when they are not statistically significant.

The direction of the variables' effects on the death rate shown by the zero-order correlations is not always duplicated by the results of the regression equations (Table 8). In particular, four variables whose bivariate relationships with mortality are negative tend to show positive signs when incorporated into the equations with the

other variables. Urbanization, doctors per capita, income, and total expenditures on food all show some positive signs in the equations, although not always consistently and not always with statistical significance.

These results corroborate what we already know, that the determination of mortality is a complex phenomenon and that relationships are not always what they seem to be on the surface. *A priori* reasoning and the results of some other investigations might lead one to expect relationships like those shown by the zero-order correlations. Across nations, for example, Adelman (1963) found that higher levels of economic development, urbanization, and medical care were all associated with lower levels of mortality. Other studies, within nations but often restricted to only one level of the framework, also find such relationships: Kitagawa and Hauser (1973) find a negative relationship between income and mortality, even with education controlled for. The reversals found in the present study, and similar results in other studies discussed below, suggest that the other findings may be partly the product of uncontrolled factors at work. If these reversed relationships are valid and not just the product of low statistical reliability, how might they be explained?

Urbanization is such a general phenomenon, correlated with so many aspects of society, that it is not surprising to find it has both positive and negative effects on mortality and that if some of the negative effects are controlled for, the remainder may act positively. The sign of the coefficient for urbanization in the regression equations usually changed from negative to positive when the occupational variable was entered, indicating that much of the negative zero-order relationship

of urbanization with mortality is the product of the relationship between urbanization and the occupational structure.

Similarly, when education is controlled for, one of the major ways in which income affects mortality is removed, and the remaining effects of income, having to do perhaps with life-style patterns, stress, and exercise, have a net positive effect on mortality.

The sometimes positive sign of the coefficient for doctors per capita is not often statistically significant. Other researchers who have dealt with this variable have noted similar positive associations and have noted that there are likely reverse effects occurring: doctors per capita respond to the death rate as well as the death rate responds to doctors per capita (Auster, Leveson, and Sarachek, 1972).

Regarding total food expenditures, it is well known that over-indulgence in some foods may be as detrimental to health as malnutrition. While expenditures on food is not the best way to get at this phenomenon, it may well be responsible for the findings.

The overall regression equations usually explain over 60 percent of the variation in the death rates. The relative importance of the separate variables to these equations may be examined by looking at the normalized regression coefficients, the Beta-coefficients, and interpreting this information in the light of data on the statistical significance of the coefficients (Table 9).

The variable which is usually most important is the average number of persons per household, followed closely by the percent of the population over 15 with a high school education and the percent of the labor force in farming. Other variables, especially average temperature,

income, and doctors per capita, all show relatively little importance once included with the other variables.

Two of the three most important variables, persons per household and education, show decreasing regression coefficients over time, suggesting that the death rate is becoming less sensitive to differences in these variables. Urbanization and the percent in farming, on the other hand, show some evidence of increasing importance.

These results may be compared with the findings of several other investigators, in particular Yamamoto and Hayashi for Japan (1971), and Silver (1973) and Auster, Leveson and Sarachek (1973) for the United States. Two of these use some index of crowding or family size, not perfectly comparable to our measure of persons per household. Neither finds this factor to be especially important, in contrast to the above results. On the other hand, in regression studies for the United States, education was found to be of major importance, even though entangled with the effects of income and occupation. One of these studies also found the occupational structure to be of major importance. Both the United States studies also show a positive relationship of income and mortality when other factors are controlled for. The effect of urbanization, when other factors are included in the analysis, is found to be of low importance and uncertain direction.

The importance of the variable persons per household in the regressions was somewhat unexpected. Tentative hypotheses were that a more direct measure of crowding, the number of tatami mats per person in a household, would be more important and that persons per household would be of almost no importance.

Just how does this variable operate to affect the death rate? Contacts

with a large number of people would theoretically lead to a greater chance of exposure to disease. Also, a large number of persons to interact with might lead to higher levels of stress, although the mitigating effects of culture would be of primary importance here. A higher household size might indicate some age-structure differences among the prefectures, but these would not be reflected in differences in an age-standardized death rate. We will say more about this variable after the examination by causes of death.

The importance of education is expected; this variable is almost invariably strongly negatively related to mortality no matter what the investigative approach. It is presumed that the effect is because of the greater ability of educated people to deal with many of the problematic aspects of life, including preventing and treating the avoidable diseases. The causes of death most important to the effect of this variable, and also of the percent in farming, will be discussed below.

Mathematically, if each cause of death rate is regressed on the independent variables, the coefficient for each of the independent variables for the different causes will sum to their coefficients for the total death rate. The results of such a procedure are, however, strongly influenced by the overall importance of the cause groups cardiovascular diseases and residual causes, which would be expected to dominate the effect of any variable on the total death rate.

The positive effects of persons per household on the total death rate are transmitted most strongly through the effects of this variable on the cardiovascular death rate (Table 10). Also of

importance are positive effects on the death rates due to cancer and to pneumonia and bronchitis, the first two showing rising relative importance, the last falling. Consistently negative effects of persons per household are shown on tuberculosis and accidents other than automobile accidents.

Such results are only partly in agreement with expectations that infectious diseases and stress might be the pathways for the effect of persons per household on the death rate. Pneumonia and bronchitis and cardiovascular diseases do fit these categories to an extent, of course, but the effects on cancer and tuberculosis are not easily explained.

The negative effects of education on the death rate come first of all through the residual causes of death, which cannot be further analyzed with the available data. The effect of high school education on cardiovascular diseases, on the other hand, is consistently positive and usually second in importance, thus somewhat counteracting the effect through the residual group. Other effects reinforcing the net negative effect are felt through tuberculosis, intestinal diseases, pneumonia and bronchitis, and accidents other than automobile accidents.

If we assume that much of the effect of high school education on the residual group is on the infectious and parasitic diseases, then by and large hypotheses about the cause groups this variable works through are supported. The only diseases which are consistently higher for high levels of education are cardiovascular diseases and neoplasms, and life-styles must be playing an important part here. All other disease groups are negatively related to levels of education.

The positive effect of the percent of the labor force in farming on

the total death rate is dominated by its positive effect on cardiovascular diseases, which is surprising since the energetic life is supposed to reduce the incidence of cardiovascular disease. No other pathway is ever as important. Smaller but consistently positive effects of the percent in farming are felt through pneumonia and bronchitis, while automobile accidents and cancer are consistently negatively related to this variable.

Conclusions

We see for Japan in the two decades after 1950 a period of continuation of trends which dominated the previous 30 years: the decline in mortality, the decrease in differences in mortality for the prefectures, and the increase in the sex differential in mortality. The causes of death contributing most to the fall were the preventable diseases, while the main source of the remaining prefectural differences were cardiovascular diseases. This group plus neoplasms and automobile accidents were the basic sources of the rising sex mortality differential.

Among the social factors examined, persons per household, education, and the percent in farming proved to be the most important determinants of mortality at each census date, although the first two have been falling in importance.

All of the social factors studied, with the exception of automobile accidents, show a growing similarity of their values for the different prefectures over time, and this undoubtedly underlies the convergence in levels of mortality. As these social, economic, and medical and public health factors become more and more equalized throughout the country, we may expect to find less and less difference in mortality,

and that which remains will likely be due to factors which lie outside man's current abilities to control, factors basically of the natural environment.

The comparative studies show that Japanese mortality experience seems to be following the path taken earlier by Western countries. The similarities between Japan and the West and the differences between Japan and the currently developing countries make it uncertain whether these countries will follow the same paths as mortality falls.

Table 1. Expectation of life at birth (e_0) in years, by sex, and sex differential: Japan, 1950-1970

Year	Male	Female	Female minus male
1950	57.53	60.98	3.45
1955	63.76	67.95	4.19
1960	65.42	70.29	4.87
1965	67.80	72.99	5.19
1970	69.41	74.79	5.38

TABLE 2 Causes of death by group, B-list correspondence, and causes included in each group

Group number	Abbreviation	B-list number	Causes included in this group
1	TB	1,2	Tuberculosis
2	CAN	18	Malignant neoplasms
3	DEG	20,33, 37,38	Certain degenerative diseases (diabetes, ulcer, cirrhosis,nephritis)
4	CV	22,25-29	Cardiovascular diseases
5	PB	31,32	Pneumonia and bronchitis
6	INT	36	Intestinal diseases (gastritis, duodenitis,enteritis, and colitis)
7	CAR	E47	Automobile accidents
8	ACC	E48,E49	Other accidents, suicide
9	OTH	3-17,19,21, 23,24,30,34, 35,39-46,50	All other causes (other infectious and parasitic, non-malignant tumors, anemias, non-meningococcal meningitis, rheumatic fever, influenza,appendicitis, intestinal obstructions and hernia, hyperplasia of prostate, maternal maternity, diseases peculiar to infancy and early childhood, senility, homicide, war, all others)
10	TOT	1-E50	Total of all causes

Table 3 Measures of mortality and mortality change by sex and cause: Japan, 1955-1965

Sex	Year	TB	CAN	DEG	CV	PB	INT	CAR	ACC	OTH	TOT
					Standardized death rates						
Male	1955	63.60	93.90	56.89	225.88	60.14	34.00	11.16	76.64	287.49	909.70
	1960	39.40	102.40	45.36	242.13	49.25	20.90	20.93	67.77	213.26	801.40
	1965	25.00	106.10	37.82	240.03	31.30	11.50	25.53	52.07	157.45	686.60
Female	1955	44.50	72.70	35.99	172.99	49.04	34.40	3.15	34.45	249.78	697.00
	1960	22.30	75.00	27.44	173.43	38.36	20.40	5.37	32.13	178.57	573.00
	1965	11.70	73.80	21.07	165.63	22.75	10.90	6.47	22.63	130.65	465.60
					Cause-specific rates as a proportion of total standardized death rates						
Male	1955	.0699	.1032	.0625	.2483	.0661	.0374	.0123	.0843	.3160	1.0000
	1960	.0492	.1278	.0566	.3021	.0615	.0261	.0261	.0846	.2661	1.0000
	1965	.0364	.1545	.0551	.3495	.0456	.0167	.0372	.0758	.2239	1.0000
Female	1955	.0639	.1043	.0516	.2482	.0704	.0494	.0045	.0494	.3584	1.0000
	1960	.0389	.1309	.0479	.3027	.0670	.0356	.0094	.0561	.3116	1.0000
	1965	.0251	.1585	.0453	.3557	.0449	.0234	.0139	.0486	.2806	1.0000
					Changes in cause-specific death rates						
Male	1955-65	-38.60	12.20	-19.07	14.15	-28.84	-22.50	14.37	-24.57	-130.04	-222.90
Female	1955-65	-32.80	1.10	-14.92	- 7.36	-26.29	-23.50	3.32	-11.82	-119.13	-231.40
					Proportion of total change due to each cause						
Male	1955-65	.1732	-.0547	.0856	-.0635	.1294	.1009	-.0645	.1102	.5834	1.0000
Female	1955-65	.1418	-.0048	.0645	.0318	.1136	.1016	-.0144	.0511	.5148	1.0000

NOTE: Death rates in deaths per 100,000 population. For key to cause groups, see Table 2.

Table 5 Sex differentials in mortality, differentials as proportions of total sex differentials, and changes in these measures, by cause: Japan, 1955-1965

	TB	CAN	DEG	CV	PB	INT	CAR	ACC	OTH	TOT
					Male minus female standardized death rate					
1955	19.10	21.20	20.90	52.89	11.10	-0.40	8.01	42.19	37.71	212.70
1960	17.10	27.40	17.92	68.70	10.89	0.50	15.56	35.64	34.69	228.40
1965	13.30	32.30	16.75	74.40	8.55	0.60	19.06	29.44	26.80	221.20
					1955-65 change in sex differential					
	-5.80	11.10	-4.15	21.51	-2.55	1.00	11.05	-12.75	-10.91	8.50
					Sex differential by cause as a proportion of total sex differential					
1955	.0898	.0997	.0983	.2487	.0522	-.0019	.0377	.1984	.1773	1.0000
1960	.0749	.1200	.0785	.3008	.0477	.0022	.0681	.1560	.1519	1.0000
1965	.0601	.1460	.0757	.3364	.0387	.0027	.0862	.1331	.1212	1.0000
					1955-65 change in proportion of total sex differential					
	-.0297	.0463	-.0226	.0877	-.0135	.0046	.0485	-.0653	-.0561	0.0000

NOTE: Death rates in deaths per 100,000.
For key to cause of death groups, see Table 2.

TABLE 4 . Variance of each cause of death group as a proportion of the sum of these variances, by sex, Japan, 1955-1965

	Male			Female		
Cause	1955	1960	1965	1955	1960	1965
TB	.0382	.0260	.0207	.0420	.0254	.0139
CAN	.0344	.0426	.0487	.0178	.0224	.0291
DEG	.0141	.0141	.0176	.0137	.0118	.0148
CV	.5701	.6481	.6893	.3903	.5110	.6579
PB	.0317	.0254	.0135	.0529	.0463	.0216
INT	.0212	.0057	.0029	.0422	.0189	.0091
CAR	.0018	.0094	.0179	.0003	.0014	.0027
ACC	.0346	.0339	.0535	.0127	.0193	.0155
OTH	.2541	.1948	.1359	.4281	.3435	.2354
SUM	1.0002	1.0000	1.0000	1.0000	1.0000	1.0000

NOTE: The sums do not include the residual variance which is the difference between these sums and the variance for the total SDR.

For key to cause groups, see Table 2.

Table 6 Key to variable names

Notation	Variable
HS	Percent of the population aged 15 and over with at least a high school education
INC	Average household income, in constant yen, adjusted for household size
MD	Number of medical doctors per 1000 population
OC5	Percent of labor force of given sex in farming and lumbering occupations
PPH	Number of persons per household
PR1	Average monthly household expenditures on all food
PR7	Average monthly household expenditures on clothing
TEMP	Average temperature in degrees Centigrade
URB	Percent of the population living in urban areas

Table 7 Zero-order correlations between independent variables and standardized death rates, by sex: Japan, 1950-1970

	Male standardized death rate					Female standardized death rate				
	1950	1955	1960	1965	1970	1950	1955	1960	1965	1970
HS	-.526	-.529	-.474	-.660	-.670	-.602	-.614	-.698	-.736	-.706
INC	-.058	.045	-.086	-.475	-.633	-.045	-.054	-.239	-.592	-.624
MD	-.414	-.429	-.416	-.409	-.269	-.486	-.564	-.510	-.428	-.330
OC5	.455	.393	.454	.663	.785	.476	.451	.507	.688	.733
PPH	.668	.748	.708	.740	.418	.710	.749	.696	.706	.536
PR1	-.071	-.105	-.276	-.603	-.596	-.067	-.203	-.467	-.651	-.551
PR7	-.122	-.056	-.296	-.630	-.579	-.068	-.036	-.418	-.609	-.490
TEMP	-.490	-.556	-.509	-.484	-.276	-.553	-.550	-.418	-.458	-.384
URB	-.432	-.314	-.386	-.585	-.582	-.487	-.447	-.600	-.638	-.561

NOTE: For key to variable names, see Table 6.
Levels of significance: .05: .245; .01: .342; .001: .443.

Table 8 Coefficients and their standard errors for independent variables in the basic regression equations, by sex: Japan, 1950-1970

Dependent variable:	Male standardized death rate					Female standardized death rate				
Independent variable	1950	1955	1960	1965	1970	1950	1955	1960	1965	1970
URB	0.622*	-0.051	0.033*	0.681*	1.880*	-1.302	0.418*	-0.626	1.974*	0.992*
	(2.004)	(1.781)	(1.593)	(1.177)	(0.977)	(1.809)	(1.516)	(1.115)	(0.855)	(0.643)
TEMP	-0.107	-0.048	-0.013	-0.035	0.013*	-0.150	-0.033	0.015*	-0.011	-0.006
	(0.087)	(0.062)	(0.049)	(0.034)	(0.034)	(0.082)	(0.046)	(0.029)	(0.020)	(0.017)
HS	-0.095	-0.034	-0.013	-0.010	-0.014	-0.121	-0.031	-0.033	-0.013	-0.014
	(0.046)	(0.030)	(0.021)	(0.015)	(0.012)	(0.044)	(0.022)	(0.012)	(0.009)	(0.006)
MD	1.221*	0.185*	-0.288	0.018*	-0.111	1.155*	-0.213	0.059*	0.097*	-0.035
	(0.919)	(0.643)	(0.483)	(0.292)	(0.202)	(0.888)	(0.471)	(0.282)	(0.171)	(0.111)
OC5	1.367	0.579	1.754	1.852	5.352	-0.739*	0.837	0.740	2.230	1.017
	(2.573)	(2.012)	(1.687)	(1.449)	(.1325)	(1.839)	(1.351)	(0.923)	(0.819)	(0.637)
INC#	-0.02	0.04	0.03*	0.01*	0.03*	0.03*	0.01*	0.04*	-0.02	-0.01
	(0.08)	(0.04)	(0.05)	(0.04)	(0.03)	(0.08)	(0.03)	(0.03)	(0.02)	(0.01)
PPH	1.314	1.281	1.108	0.827	0.251	1.101	0.756	0.495	0.323	0.095
	(0.474)	(0.335)	(0.330)	(0.288)	(0.274)	(0.445)	(0.248)	(0.192)	(0.164)	(0.134)
PR1	0.002*	0.002*	0.002*	0.0004*	-0.00001	0.002*	0.001*	0.001*	-0.00001	-0.00002
	(0.002)	(0.001)	(0.001)	(0.0005)	(0.00049)	(0.001)	(0.001)	(0.001)	(0.00028)	(0.00026)
PR7	-0.008	-0.004	-0.003	-0.002	-0.00015	-0.006	-0.002	-0.001	-0.00012	-0.0003
	(0.003)	(0.003)	(0.002)	(0.001)	(0.0007)	(0.003)	(0.002)	(0.001)	(0.00055)	(0.0003)

NOTE: For key to variable names, see Table 6.
* indicates change of sign from zero-order correlation.
\# indicates coeffients and standard errors of INC have been multiplied by 1000.

Table 9 Beta-coefficients for independent variables in the basic regression equations, by sex: Japan, 1950-1970

Dependent variable	Male standardized death rate					Female standardized death rate				
Independent variable	1950	1955	1960	1965	1970	1950	1955	1960	1965	1970
URB	0.108	-0.009	0.007	0.165	0.498	-0.219	0.095	-0.205	0.787	0.573
TEMP	-0.186	-0.113	-0.045	-0.013	0.055	-0.252	-0.101	0.077	-0.069	-0.054
HS	-0.391	-0.216	-0.132	-0.128	-0.214	-0.483	-0.261	-0.505	-0.269	-0.440
MD	0.262	0.052	-0.099	0.007	-0.054	0.240	-0.079	0.031	0.061	-0.038
OC5	0.169	0.091	0.338	0.372	1.088	-0.106	0.213	0.281	0.930	0.563
INC	-0.040	0.122	0.095	0.048	0.215	0.058	0.061	0.198	-0.159	-0.098
PPH	0.516	0.602	0.605	0.464	0.147	0.419	0.467	0.412	0.298	0.121
PR1	0.227	0.231	0.686	0.215	-0.006	0.203	0.184	0.505	-0.009	-0.027
PR7	-0.332	-0.250	-0.324	-0.330	-0.113	-0.273	-0.162	-0.151	-0.040	-0.137

NOTE: For key to variable names, see Table 6.

Table 10. Coefficients from equations regressing death rates by cause on independent variables, and these coefficients as percentages of coefficients for total death rate equations, by sex: Japan, 1955-1965

	Males						Females					
	Coefficients			Percentages			Coefficients			Percentages		
	1955	1960	1965	1955	1960	1965	1955	1960	1965	1955	1960	1965
						Persons per household						
TOT	111.44**	110.45**	63.62*	100.0	100.0	100.0	71.61**	57.97**	27.77	100.0	100.0	100.0
TB	-11.25	-9.22	-7.64	-10.1	-8.3	-12.0	-7.60	-6.62	-4.59*	-10.6	-11.4	-16.5
CAN	12.23*	14.17	18.80*	11.0	12.8	29.5	8.57	10.53**	10.08**	12.0	18.2	36.3
DEG	3.85	0.09	-5.73	3.5	0.1	-9.0	2.69	-2.48	-4.02*	3.8	-4.3	-14.5
CV	91.04**	96.32**	76.84**	81.7	87.2	120.8	56.97**	47.45**	31.44**	79.6	81.9	113.2
PB	19.67**	15.14**	5.27	17.7	13.7	8.3	13.40**	11.24**	2.07	18.7	19.4	7.5
INT	1.04	1.08	0.07	0.9	1.0	0.1	-0.43	1.40	1.58	-0.6	2.4	5.7
CAR	-0.40	2.16	3.76	-0.4	2.0	5.9	-0.14	0.63	0.52	-0.2	1.1	1.9
ACC	-12.56	-10.91	-17.97**	-11.3	-9.9	-28.3	-6.06	-4.00	-5.43*	-8.5	-6.9	-19.6
OTH	7.81	1.61	-9.77	7.0	1.5	-15.4	4.22	-0.19	-3.89	5.9	-0.3	-14.0
Sum	111.44	110.45	63.62	100.0	100.0	100.0	71.61	57.97	27.77	100.0	100.0	100.0
						High school education						
TOT	-4.33	-2.42	-1.33	100.0	100.0	100.0	-3.74	-3.42**	-1.31	100.0	100.0	100.0
TB	-0.95	-0.77*	-0.42*	21.9	31.9	31.3	-0.77	-0.54*	-0.22*	20.6	15.9	16.8
CAN	0.59	0.64	0.42	-13.6	-26.6	-31.4	0.09	0.22	0.15	-2.4	-6.4	-11.4
DEG	0.42	-0.13	-0.03	-9.8	5.3	2.0	0.23	-0.10	-0.06	-6.1	2.8	4.9
CV	0.93	1.17	1.30	-21.6	-48.3	-97.4	1.23	0.43	0.59	-32.8	-12.5	-45.3
PB	-0.44	-0.49	-0.34	10.1	20.2	25.3	-0.46	-0.53	-0.31*	12.4	15.5	23.7
INT	-0.77	-0.25	-0.18	17.7	10.4	13.4	-0.79	-0.35	-0.14	21.1	10.1	10.7
CAR	-0.03	-0.03	-0.16	0.7	1.3	11.8	-0.03	-0.01	-0.08	0.9	0.3	6.2
ACC	-1.02	-1.05*	-0.71*	23.4	43.2	53.7	-0.35	-0.69**	-0.28*	9.4	20.2	21.5
OTH	-3.08*	-1.51	-1.22	71.1	62.5	91.4	-2.87*	-1.85*	-0.95*	76.8	54.0	72.8
Sum	-4.33	-2.42	-1.33	100.0	100.0	100.0	-3.74	-3.43	-1.31	100.0	100.0	100.0

NOTE: For key to variable names, see Table 6.

** significant at p less than .01 * significant at p less than .05

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